

CLAIMS

1. A liquid crystal display device, comprising:

a first substrate, a second substrate, and a liquid
crystal layer provided between the first substrate and the
5 second substrate;

the liquid crystal display device having a plurality of
picture element regions;

wherein:

the first substrate includes a picture element electrode
10 provided on the side of the liquid crystal layer, the picture
element electrode being provided in each of the plurality of
picture element regions, and a switching element electrically
connected to the picture element electrode;

the second substrate includes a counter electrode
15 opposing the picture element electrode with the liquid
crystal layer interposed therebetween; and

in each of the plurality of picture element regions, the
picture element electrode includes a solid portion including
a plurality of unit solid portions; and the liquid crystal
20 layer is in a vertical orientation state when no voltage is

applied between the picture element electrode and the counter electrode, and when a voltage is applied between the picture element electrode and the counter electrode, forms a liquid crystal domain taking a radially-inclined orientation in a region corresponding to each of the plurality of unit solid portions by an oblique electric field produced in the vicinity of each of the plurality of unit solid portions of the picture element electrode;

the liquid crystal display device further comprising, in each of the plurality of picture element regions, a storage capacitor connected electrically in parallel to a liquid crystal capacitor which includes the picture element electrode, the counter electrode, and the liquid crystal layer; wherein:

in each of the plurality of picture element regions, the first substrate has an area where no solid portion of the picture element electrode is provided; and

at least a part of the storage capacitor is located in the area of the first substrate where no solid portion is provided.

2. The liquid crystal display device of claim 1, wherein the switching element is a thin film transistor.

5 3. The liquid crystal display device of claim 2, wherein the storage capacitor includes a storage capacitor line, a storage capacitor electrode opposing the storage capacitor line and electrically connected to a drain electrode of the thin film transistor, and a first insulating layer provided
10 between the storage capacitor line and the storage capacitor electrode.

4. The liquid crystal display device of claim 3, wherein at least a part of the storage capacitor line, at least a
15 part of the storage capacitor electrode, and at least a part of the first insulating layer are located in the area.

5. The liquid crystal display device of claim 3 or 4, wherein the first substrate includes a scanning line
20 electrically connected to a gate electrode of the thin film

transistor and a signal line electrically connected to a source electrode of the thin film transistor.

6. The liquid crystal display device of claim 5,
5 wherein:

the storage capacitor line includes at least one line stem extending generally parallel to the scanning line and a line branch branched from the at least one line stem; and

the storage capacitor electrode includes at least one
10 electrode stem opposing the at least one line stem with the first insulating layer interposed therebetween and an electrode branch branched from the at least one electrode stem.

15 7. The liquid crystal display device of claim 6, wherein the line branch and the electrode branch are branched so as to overlap a central portion of one of the plurality of unit solid portions or the vicinity thereof.

20 8. The liquid crystal display device of claim 6 or 7,

wherein the at least one line stem is a plurality of line stems, and the at least one electrode stem is a plurality of electrode stems.

5 9. The liquid crystal display device of any one of claims 3 through 8, wherein:

the first substrate further includes a second insulating layer for covering at least the thin film transistor and the storage capacitor electrode; and

10 the picture element electrode is provided on the second insulating layer.

10. The liquid crystal display device of claim 9, wherein the second insulating layer is formed of a resin
15 material.

11. The liquid crystal display device of any one of claims 1 through 10, wherein the plurality of unit solid portions each have a shape having rotational symmetry.

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12. The liquid crystal display device of any one of claims 1 through 11, wherein the plurality of unit solid portions each have a generally circular shape.

5 13. The liquid crystal display device of any one of claims 1 through 11, wherein the plurality of unit solid portions each have a generally rectangular shape with generally arc-shaped corners.

10 14. The liquid crystal display device of any one of claims 1 through 11, wherein the plurality of unit solid portions each have a shape with acute corners.

15 15. The liquid crystal display device of any one of claims 1 through 14, wherein the plurality of unit solid portions have substantially the same shape and substantially the same size as one another, and form at least one unit lattice arranged to have rotational symmetry.

20 16. The liquid crystal display device of any one of

claims 1 through 15, wherein the picture element electrode further has at least one opening, and the liquid crystal layer forms a liquid crystal domain taking a radially-inclined orientation in a region corresponding to the at least one opening by the oblique electric field when a voltage is applied between the picture element electrode and the counter electrode.

17. The liquid crystal display device of claim 16, wherein the at least one opening includes a plurality of openings having substantially the same shape and substantially the same size as one another, and at least some of the plurality of openings forms at least one unit lattice arrange to have rotational symmetry.

18. The liquid crystal display device of claim 17, wherein each of the at least the some of the plurality of openings has a shape having rotational symmetry.

19. The liquid crystal display device of claim 17 or 18,

wherein each of the at least the some of the plurality of openings has a generally circular shape.

20. The liquid crystal display device of any one of
5 claims 17 through 19, wherein in each of the plurality of picture element regions, a sum of area sizes of the plurality of openings of the picture element electrode is smaller than an area size of the solid portion of the picture element electrode.

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21. The liquid crystal display device of any one of
claims 17 through 20, further comprising a protrusion provided in each of the plurality of openings of the picture element electrode, wherein the protrusion has the same cross-
15 sectional shape as that of the plurality of openings in a planar direction, and a side surface of the protrusion exerts an orientation-regulating force acting upon the liquid crystal molecules in the liquid crystal layer in the same direction as an orientation-regulating direction provided by
20 the oblique electric field.

22. The liquid crystal display device of any one of claims 1 through 21, wherein the second substrate has an orientation-regulating structure in an area corresponding to each of the plurality of unit solid portions, the orientation-regulating structure exerting an orientation-regulating force for placing the liquid crystal molecules in the liquid crystal layer into a radially-inclined orientation at least in a state where a voltage is applied between the picture element electrode and the counter electrode.

23. The liquid crystal display device of claim 22, wherein the orientation-regulating structure is provided in an area corresponding to a central portion of each of the plurality of unit solid portions or the vicinity thereof.

24. The liquid crystal display device of claim 22 or 23, wherein in the liquid crystal domain formed in correspondence with each of the plurality of unit solid portions, the orientation-regulating direction provided by the orientation-

regulating structure is in conformity with the direction of the radially-inclined orientation provided by the oblique electric field.

5 25. The liquid crystal display device of any one of claims 22 through 24, wherein the orientation-regulating structure exerts an orientation-regulating force even in a state where no voltage is applied between the picture element electrode and the counter electrode.

10 26. The liquid crystal display device of any one of claims 22 through 25, wherein the orientation-regulating structure is a protrusion included in the counter substrate and protruding toward the liquid crystal layer.

15 27. The liquid crystal display device of claim 25 or 26, wherein a part of the storage capacitor overlaps the orientation-regulating structure.

20 28. The liquid crystal display device of any one of

claims 1 through 27, wherein the liquid crystal domain takes a spiral radially-inclined orientation.

29. A liquid crystal display device, comprising:

5 a first substrate, a second substrate, and a liquid crystal layer provided between the first substrate and the second substrate;

the liquid crystal display device having a plurality of picture element regions;

10 wherein:

the first substrate includes a picture element electrode provided on the side of the liquid crystal layer, the picture element electrode being provided in each of the plurality of picture element regions, and a switching element electrically
15 connected to the picture element electrode;

the second substrate includes a counter electrode opposing the picture element electrode with the liquid crystal layer interposed therebetween; and

in each of the plurality of picture element regions, the
20 picture element electrode has at least one opening or slit;

and the liquid crystal layer is in a vertical orientation state when no voltage is applied between the picture element electrode and the counter electrode, and when a voltage is applied between the picture element electrode and the counter electrode, is orientation-regulated by an oblique electric field produced in an edge portion of the at least one opening or slit of the picture element electrode;

the liquid crystal display device further comprising, in each of the plurality of picture element regions, a storage capacitor connected electrically in parallel to a liquid crystal capacitor which includes the picture element electrode, the counter electrode, and the liquid crystal layer; wherein:

at least a part of the storage capacitor overlaps the at least one opening or slit of the picture element electrode.

30. The liquid crystal display device of claim 29, wherein the switching element is a thin film transistor.

31. The liquid crystal display device of claim 30,

wherein the storage capacitor includes a storage capacitor line, a storage capacitor electrode opposing the storage capacitor line and electrically connected to a drain electrode of the thin film transistor, and a first insulating layer provided between the storage capacitor line and the storage capacitor electrode.

32. The liquid crystal display device of claim 31, wherein:

10 the first substrate further includes a second insulating layer for covering at least the thin film transistor and the storage capacitor electrode; and

the picture element electrode is provided on the second insulating layer.

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33. The liquid crystal display device of claim 32, wherein the second insulating layer is formed of a resin material.